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Distribution and Structural Significance of the Oakdale Formation in Northeastern Connecticut

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DISTRIBUTION AND STRUCTURAL SIGNIFICANCE OF THE OAKDALE FORMATION IN NORTHEASTERN CONNECTICUT

by

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INTRODUCTION

Extensive geologic quadrangle mapping in recent years by the U.S. Geological Survey in cooperation with the states of Massachusetts and Connecticut has provided a coherent interpretation of the stratigraphy and structure of a region extending from east-central Massachusetts into northeast Connecticut (Peper and Pease, 1976; Barosh, Fahey and Pease, 1977; and Barosh, 1974 and 1977) (Fig. 1). As mapping progressed in this region, knowledge of the stratigraphy was increased and map units were refined. This new information has necessitated revision of stratigraphic relationships and in many places structural interpretations as presented by previous workers. The most significant advance is recognition that the Oakdale Formation can be traced into Connecticut and is equivalent to strata formerly mapped as part of the Hebron Formation and Scotland Schist. This guide will show the distinguishing lithologic and stratigraphic characteristics of the Oakdale Formation in the region and discuss the structural significance of this improved stratigraphic control. A one day trip does not provide time to adequately trace the Oakdale through Connecticut. Instead, exposures of lithologies representative of the Oakdale and of strata overlying it will be seen south of its type area in southern Massachusetts and along two other general traverses farther south in northeastern Connecticut to demonstrate that the sequence extends southward.

In Massachusetts the Oakdale Formation and younger Paxton Group lie both physically and in apparent right-side-up position stratigraphically beneath the Brimfield Group rocks (Fig. 1). The Brimfield Group is a thick homoclinal west-facing succession that underlies much of south-central Massachusetts and extends across New Hampshire. The Clinton-Newbury fault zone, a major structural discontinuity in Massachusetts, across which no stratigraphic correlation has been possible, separates the Oakdale-Paxton-Brimfield succession from rocks of the Nashoba and underlying Marlborough Formations to the east. The Nashoba and Marlborough continue into Connecticut as the Putnam Group. The Oakdale-Paxton, composed of schistose granulite and metasiltstone respectively, form a belt of strata in eastern Connecticut that have been variously termed Hebron, Scotland and Southbridge Formations (Dixon and Lundgren, 1968; Pease, 1972).

The structural block containing the Paxton-Oakdale (Hebron) sequence in

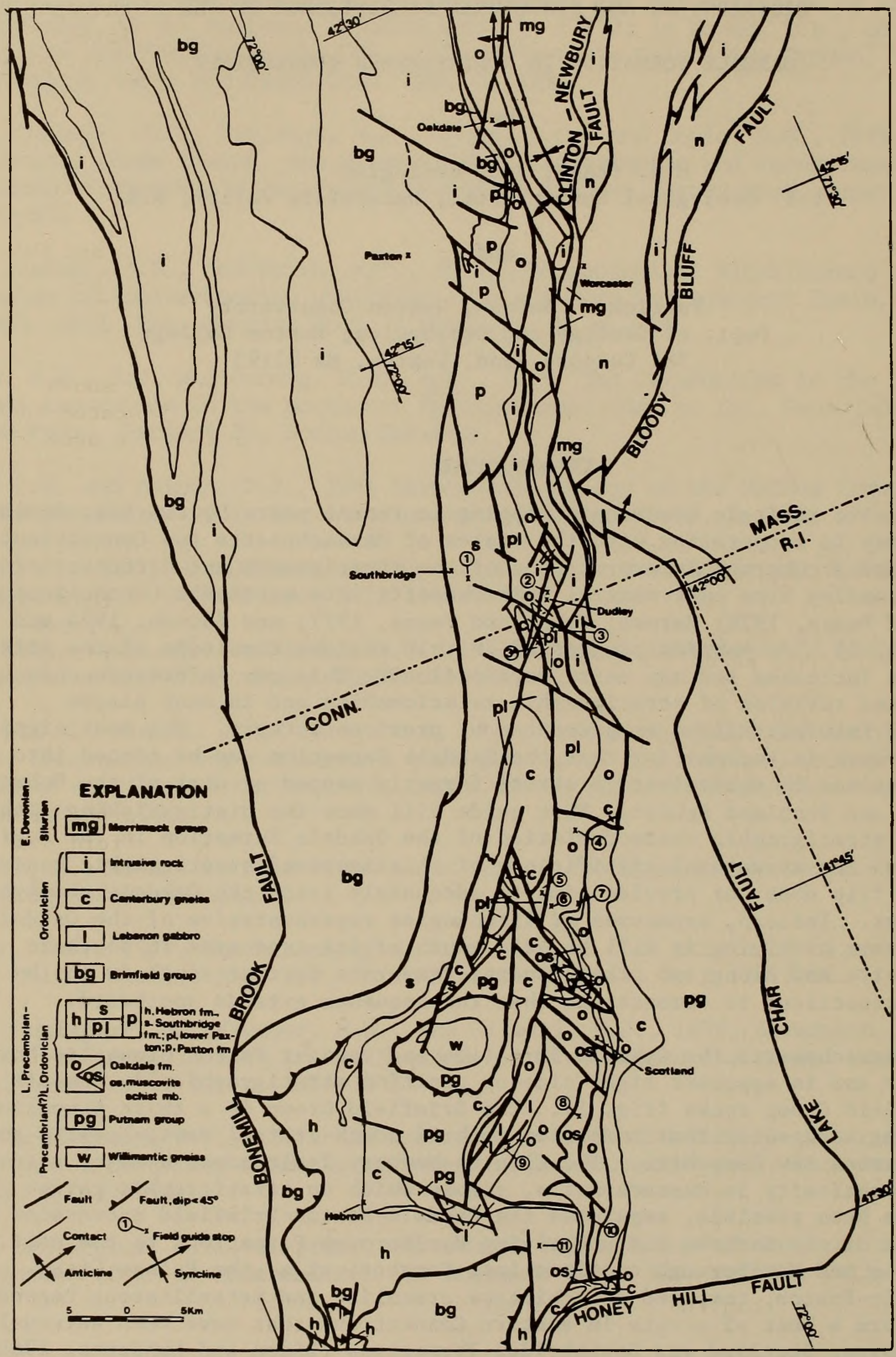

Figure 1. Simplified geologic map of south-central Massachusetts and eastern Connecticut showing distribution of the Oakdale-Paxton sequence of metasedimentary rock.

Connecticut is bounded on the west by the Black Pond fault and on the east by the Clinton-Newbury fault zone. The structural position of the Clinton-Newbury fault zone in Connecticut is invaded and masked by foliated intrusive rock.

HISTORICAL CONTEXT

Emerson's Geologic map (1917) shows that the Brimfield, Paxton and Oakdale extend to the Connecticut state line. To the south in Connecticut this sequence was described as Brimfield Schist and Hebron Gneiss (Gregory and Robinson, 1907; Rodgers and others, 1959). The Oakdale lies east of and structurally beneath the Paxton; the Brimfield lies mostly west of and structurally above the Paxton (Fig. 2) although belts of Paxton also are shown within the eastern part of the Brimfield. Emerson (1917, p. 62) stated that "The Paxton passes in pitching folds beneath the Brimfield" in this area. He also considered the Paxton to be a higher metamorphic grade equivalent of the Oakdale.

During the period 1955-1968 much of eastern Connecticut was mapped at a scale of 1:24,000 by the U.S. Geological Survey in cooperation with the Connecticut Geological and Natural History Survey. As a result of this work, which was summarized by H.R. Dixon and L.W. Lundgren, Jr. (1968), a three-fold stratigraphic sequence was established for northeastern Connecticut consisting of Scotland Schist at the top, Hebron Formation in the middle and Putnam Group (Tatnic Hill Formation overlying the Quinebaug Formation) at the base (Fig. 2). The Brimfield Group was considered to be an inverted equivalent of the Tatnic Hill Formation resting structurally on the Hebron.

From 1966 to 1975 detailed geologic mapping was undertaken in the Brimfield area of Connecticut and Massachusetts, beginning in the Eastford quadrangle (Pease, 1972). This work resulted in redefinition of the Hebron Formation and Brimfield Schist of Connecticut and adjacent Massachusetts. It demonstrated that the "folds" of Paxton in the Brimfield are intervals of amphibolite and pyroxene-bearing biotite schist and gneiss within the Brimfield and not part of the type Paxton.

In the Eastford quadrangle report (Pease, 1972) the Hebron Formation was divided into two distinct groups of rocks separated by the northeast-trending Eastford fault. Strata northwest of the fault were named the Southbridge Formation with the type area in Southbridge, Massachusetts, immediately to the north of the Eastford quadrangle where the formation had been mapped by G.E. Moore, Jr. (1978). These strata form the upper part of the Paxton of Emerson. The Hebron Formation and Scotland Schist were restricted to the east side of the fault in the Eastford quadrangle report (Fig. 2).

The Southbridge Formation is a more heterogeneous and generally coarser-grained sequence than the Hebron Formation. The Southbridge consists mostly of dark- and light-gray, well layered, medium- to coarse-grained biotite gneiss and schist with less common amphibolite and sulfidic schist lenses; the Hebron is a medium-gray to greenish-gray, uniformly thin-layered, fine-grained, biotite schistose granulite.

Emerson 1917		Dixon & Lundgren 1968	Pease, 1972 Peper, Pease & Seiders 1975		Barosh, 1977
Brimfield Schist	Worcester Phyllite	Scotland Schist	Brimfield Group: Mt. Pisgah Formation; Hamilton Reservoir Formation	Brimfield Group	
			—FAULT—		Bigelow Brook Formation
			Bigelow Brook Formation		
			—BLACK POND FAULT—		
Paxton quartz schist / Oakdale quartzite		Hebron Formation	Southbridge Formation	Paxton Group	Southbridge Formation
			—EASTFORD FAULT—		
			Scotland Schist		"Lower Paxton"
			Hebron Formation		
					Oakdale Formation
	Brimfield Schist	Tatnic Hill Formation of Putnam Group			Nashoba-Marlborough Sequence

Fig. 2 - Evolution of stratigraphic terminology in central Massachusetts and northeast Connecticut prior to recognition of the Oakdale Formation in Connecticut (not a correlation chart).

Modern geologic mapping of the Oakdale and Paxton strata in adjacent Massachusetts was started in the early 1970's. A program of geologic mapping under the direction of P.J. Barosh, then with the U.S. Geological Survey, was undertaken in the region from Worcester into the northeast corner of Connecticut. In an open-file report on geology of this region (Barosh, 1977), the name Oakdale quartzite was informally changed to Oakdale Formation, on the basis that it is mostly metasiltstone with little or no true quartzite. The Paxton quartz schist was informally redefined as the Paxton Group because the Southbridge-Hebron division, recognized in the Eastford quadrangle, Connecticut, was also recognized in the contiguous Paxton of southeastern Massachusetts. The Oakdale was shown to be older than the Paxton Group rather than equivalent to the Paxton, as per Emerson.

The term Southbridge Formation is retained for the upper part of the Paxton and the remainder of the Paxton above the Oakdale is informally assigned to the "Lower Paxton".

Figure 2 shows the evolution of the stratigraphic nomenclature prior to recognition of the Oakdale Formation in Connecticut.

OAKDALE FORMATION

The Oakdale Formation is an unusually homogeneous calcareous metasiltstone that maintains its character from New Hampshire through Massachusetts to as far south as the Honey Hill fault in Connecticut (Barosh and Pease, 1981). The Scotland, formerly considered a separate formation, now has been demonstrated to be a member within the Oakdale, the most extensive of many pelitic schist intervals within the Oakdale throughout its area of exposure. Figure 3 shows the correlation of stratigraphy in eastern Connecticut and central Massachusetts as it is presently interpreted.

The characteristic and most common lithology of the Oakdale in its type area, Oakdale, Massachusetts (Fig. 1) is a medium-to dark-gray, greenish-gray and purplish-gray metasiltstone that weathers light to medium-gray, greenish or brownish-gray. It consists of "granulose silt-size quartz,plagioclase (oligoclase-andesine) and brown biotite, with minor amounts of chlorite, actinolite, garnet, staurolite, muscovite and calcite" (Peck, 1975). The metasiltstone is well bedded in thin to medium beds, commonly laminated or cross-laminated with a few graded beds. According to Peck, the rock may locally be phyllitic. Included with this dominant lithology are small calcareous lenses and minor but conspicuous lenses of pelitic staurolite-bearing schist. The formation maintains its characteristic metasiltstone grain size regardless of proximity to intrusive rocks and even where it occurs as xenoliths.

SCOTLAND SCHIST MEMBER

The redefined Scotland Schist member of the Oakdale Formation is restricted to the conspicuous band of highly pelitic schist that lies in the

South-Central Massachusetts

Northeast Connecticut and adjacent Massachusetts

Central Eastern Connecticut

Brimfield Group

Paxton Group

Undivided

Southbridge Formation

"Lower Paxton"

Hebron Formation

micaceous schist Oakdale Formation

lenses Scotland Mem.

Fault or intrusive contact

Nashoba-Marlborough Fms.

Putnam Group

Figure 3 - Stratigraphic relations of the Paxton-Oakdale (Hebron) sequence as presently interpreted (modified from Barosh and Pease, 1981).

lower part of the Oakdale in Connecticut. The member is as much as 500 m thick at its southern end; it thins rapidly northward to less than 25m and is cut out against the Canterbury Gneiss. The schist typically is only weakly layered but strongly foliated and commonly crenulated. It is coarsely muscovitic and garnetiferous and typically contains conspicuous quartz stringers and pods. The Scotland contains successively more interlayers of metasiltstone towards the northern end of its exposure.

CONTACT RELATIONS

The contact between the Oakdale and overlying "Lower Paxton" is nearly everywhere a fault in eastern Connecticut, but in Massachusetts the contact appears to be conformable and gradational. The Oakdale is finer-grained and thinner-layered, and the rock characteristically weathers in flaky sheets rather than discrete partings parallel to layering. The schistose granulite of the overlying Paxton is in the sand size range in contrast to the silt grain size of the Oakdale.

The Oakdale is in fault and in intrusive contact with the Canterbury Gneiss and Lebanon Gabbro south of the Nightingale Brook fault along the east side of the Willimantic Dome. A narrow arcuate band of Lebanon Gabbro terminates the Oakdale to the south (Fig. 1).

AGE

No fossils have been found in the Oakdale Formation nor in any stratigraphic units associated with the Oakdale. Radiometric dates of related igneous rocks intrusive into the Oakdale and related stratigraphic units do provide possible minimum ages. An approximate age of 405 m.y. (Zartman, written commun.) has been assigned to the Canterbury Gneiss, which intrudes the Oakdale. An approximate age of 440 m.y. (Zartman, written commun.) has been assigned to the Hedgehog Hill Gneiss, which intrudes the Hamilton Reservoir Formation, part of the Brimfield Group, which lies near the top of the stratigraphic sequence at the base of which lies the Oakdale (Fig. 2). Thus the Oakdale is at least pre-Middle Devonian in age and by extrapolation pre-late Ordovician. Detrital zircons collected from the Oakdale Formation in central Massachusetts give a late Proterozoic age of 600^{+} m.y. according to Aleinikoff (1978). Conceivably this gives a maximum possible age for the Oakdale.

STRUCTURAL IMPLICATIONS

Separation of the Paxton-Oakdale sequence from the undivided Hebron in eastern Connecticut has necessitated changes in the structural interpretations. Much of the western part of eastern Connecticut was depicted as occupying the inverted limb of a recumbent fold by earlier workers. The axis of this fold was shown to trace a sinuous path across eastern Connecticut from southwest to northeast. This structure was premised on the existence of a simple

stratigraphy in which the Scotland was considered the youngest formation and to lie in the axis of the fold. Recognition that the Scotland lies in the lower part of a continuous west-topping sequence precludes such a structural hypothesis.

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ROAD LOG

Mileage Cumulative	Mileage Intermediate	
		START. Southbridge, MA. Large outcrop at intersection of Dresser Hill Rd. and Dudley Rd. at north side of bridge over Quinebaug River (off Rt. 131, 1 mile SE of circle in center of Southbridge, MA).
		STOP 1. (Southbridge Quad.) TYPE LOCALITY OF THE SOUTHBRIDGE FM. The Southbridge Fm. is the upper formation of the Paxton Gp. Lithologies representative of the entire Paxton Gp. can be seen in the outcrop, but most of this rock is coarser-grained than strata in the lower part of the group. In this large outcrop evenly-bedded, conspicuously parted strata dip about 40° to the west. Beds, 5-70 cm thick, consist of schistose granulite, chiefly meta-sandstone, with a few pelitic folia. The rock is medium- to dark-greenish-gray with a conspicuous salt and pepper granular texture; it is composed chiefly of quartz, plagioclase and biotite. A few lenticular calc-silicate-bearing granular layers are present. The alternation of coarse-, medium- and fine-grained beds in this outcrop is typical of the Southbridge. Outcrop contains numerous pods and lenses of pegmatite, as much as 1 m thick, generally parallel to bedding.
	0.0	Start road log on south side of bridge, turn left, SE, on Rt. 131. This direction is going down section. Almost the entire section of the Southbridge Fm. is well exposed along railroad cuts on opposite side of river.
1.6	1.6	Dudley town line.

Cum.	In.	
3.1	1.5	Outcrop on left, lower Paxton.
3.9	.8	Bridge of Quinebaug River, turn left, N, immediately after crossing bridge on to Mill Rd.
4.0	.1	Railroad crossing.
4.1	.1	Outcrop on left, lower Paxton.
4.6	.5	Intersection Rt. 31 and Mill Rd. Park on Mill Rd., enter woods at fire plug across Rt. 31, walk about 50 m and angle down into old railroad cut on left.

STOP 2. (Webster Quad.) OAKDALE FM. Medium- and dark-gray weathering silicic metasiltstone. Well bedded gently NW dipping. Beds generally 1-15 cm thick and commonly laminated. Few schist beds as much as 10 cm thick are present. Muscovite-rich parting surfaces are common. Composed of quartz, plagioclase, biotite and muscovite. Lavender and green tints reflect presence of biotite and calc-silicate minerals, respectively. Possible graded-bedding suggests tops up. Bedding well expressed on weathered outcrop surfaces, but freshly broken rock generally does not show bedding features. Thin quartz lenses and stringers are common. Minor intrafolial folds brought out by differentially weathered bedding show west over east transport with sheared out limbs. No evidence of regional isoclinal folding nor of axial plane cleavage is present. A few small intrafolial thrust faults also indicate west over east transport. The exposures in this extensive cut are representative of the Oakdale Fm. both in this area and at its type area at Oakdale, MA. The rock, although very resistant in fresh exposures, is a valley former relative to the "Lower Paxton Fm." to the west, which in turn is less resistant in erosion than the Southbridge. There are few natural exposures of Oakdale. The Oakdale is characterized by a thin-bedded quartz, plagioclase, biotite metasiltstone containing minor amounts of muscovite chiefly in lamellae and rarely thin beds.

Return to cars and turn right, S, onto Rt. 31.

5.0	.4	Entering Thompson, CT.
5.1	.1	Cross CT. Rt. 197 and continue S.
5.2	.1	Railroad crossing.
5.3	.1	Turn left, SE, on Rt. 131.
5.6	.3	Turn right, S, on Fabyan (Woodstock) Rd.

Traveling over till-covered Oakdale, note ridge to SE formed by intrusive complex.

Cum.	In.	
6.2	.6	Bridge over Quinebaug River, turn right across river on Fabyan (Woodstock) Rd.
6.5	.3	Keep to right on Blash Rd.
6.6	.1	Abandoned gravel pit on left; rubble covered slope of gravel pit with weathered loose outcrop.

STOP 3. (Webster Quad.) PELITIC OAKDALE. Dark gray, rusty weathering schist with siltstone interbeds 1-5 cm thick. Bedding is warped and crenulated as is common where units of different competency are interbedded. The pelitic layers are muscovite-rich and the siltstone layers are similar to those at Stop 2. The pelitic intervals within the Oakdale range from lamellae to as much as 500 m thick. Mappable muscovite intervals have been mapped as Scotland Schist in Ct, and Gove in NH and Gonic in ME. The schist in this area would probably be mappable if exposures were better. Note uplands to east formed by an intrusive complex. The western part of the intrusive rock contains xenoliths of Oakdale that show no evidence of coarsening due to contact metamorphism.

Break in log for supplementary Stop 3A. Continue 1.0 miles on Blash Rd. which becomes Chandler School Rd.

Turn left, S, on Dugg Rd., and drive about 200 feet to small exposure on left side of rd.

STOP 3A. (Webster Quad.) BASAL PAXTON. Brownish medium-gray very fine-grained thin-bedded schistose granulite or metasandstone beds 1 to 5 cm and commonly laminated. Composed of quartz, plagioclase and biotite with trace of muscovite. Has salt and pepper texture. Thin more resistant calc-silicate beds also present. The rock in this exposure appears transitional between the Oakdale metasiltstone and the fine-grained metasandstone of the "lower Paxton Fm". Note flaky partings in this weathered outcrop which are a common feature of the lower Paxton.

Rock more typical of the "lower Paxton" is exposed 0.3 miles due north of here on Converse Rd., which is an extension of Dugg Hill Rd.

Return to Stop 3 and continue road log from Stop 3.

Return 100 m to intersection Fabyan Rd., and Blash Rd., turn right, S, (Woodstock Rd. becomes Paine District Rd.)

7.6	1.0	Outcrop rusty pelitic Oakdale in bushy roadcut on right.
7.7	.1	Intersection Paine Rd. and Paine District Rd. continue straight, S.

Cum.	In.	
9.5	1.8	Bear right at V.
9.7	.2	Bear left at V onto Roseland Park Rd.
11.7	2.0	South Woodstock, CT, turn left, S, on Rt. 169.
12.0	.3	Continue on Rt. 169 to right towards Pomfret, CT.
12.3	.3	Annhurst College.
14.7	2.4	Pomfret, CT, Junction of Rts. 169 and 44, continue straight, S.
16.7	2.0	Bear left on Rt. 44.
16.8	.1	Bear right on Rt. 44.
17.3	.5	Right again, W, on Rt. 44.
18.2	.9	Mashomoquet Brook State Park entrance.
19.5	1.3	Abington, CT.
20.3	0.8	Abandoned part of old Rt. 44 on left just south of present highway. A low outcrop is present near the east end of the abandoned roadway and outcrops occur in the field to the south. Also, a small exposure can be seen on the right side of the present road.

STOP 4. (Hampton Quad.) OAKDALE FM. Very gently northwest dipping typical light-to greenish-medium-gray well-bedded metasiltstone. Beds 4 to 30 cm thick. Beds part along lamellae on weathered surfaces, muscovite-rich lamellae are sparse. Very uniform metasiltstone typical of Oakdale, possibly slightly coarser than previous stops.

This outcrop was mapped as Scotland Schist by Dixon on the basis of the presence of muscovite. The trace amount present in these rocks, however, is characteristic of typical Oakdale and not of the muscovite schist that forms the Scotland of its type area. The Scotland Member, as it is presently restricted, is a thick muscovite schist interval that lies stratigraphically much lower in the Oakdale Fm.

Continue W on Rt. 44.

20.8	.5	Passing Drown Rd. on left.
21.0	.2	Passing Lyon Brook, position of the northeast-trending Nightingale Brook fault.
21.8	.8	Good exposures of Canterbury (Eastford) granitic gneiss.

Cum.	In.	
21.9	.1	Turn left on dirt road sharply back towards E, drive 60 m and turn right, S, through gate into State forest. Note abundant float and stone fences of Canterbury Gneiss, which underlies this area.
23.6	1.7	Road enters on right, continues straight. Good exposures of Canterbury along pipeline right of way to right. Just past pipeline cross the narrow northeast-trending Catden Swamp which follows the trace of the Nightingale Brook fault.
25.1	1.5	Hampton Reservoir through trees on left. Small dirt road on left at culvert in road.
25.2	.1	3rd culvert in road after passing small dirt road. Small woods rd. on right, park and walk up woods rd. about 100 m to large outcrop (4 m high and 15 m long) to left of road.

STOP 5. (Hampton Quad.) LOWER PAXTON. Gently northwest-dipping, medium-gray schistose granulite, slightly irregularly bedded, 4-15 cm thick, strongly parted and differentially weathered. Fine-grain sand size, salt and pepper textured granulite with a few 1-4 cm thick light-green calc-silicate-bearing layers. The unevenness of the bedding may be in part due to original depositional features and concretionary nature of some calc-silicate-bearing pods, but is largely due to disruption caused by tectonic transport subparallel to bedding. Many small scale sedimentary features are still well preserved, but difficult to observe. Note the lack of muscovite lamellae and quartz lenses that are typical of the Oakdale and the greater amount of biotite than is found in the Oakdale. Pegmatite pods and stringers are present, generally subparallel tc bedding, and some sills of Canterbury are present in the upper part of the outcrop.

Return to cars and continue S along gravel rd.

25.6	.4	Paved rd., turn left, E, and immediately left into abandoned railroad grade. Do not stay on paved rd. Railroad grade crosses Nightingale Brook fault which separates "lower Paxton" from Oakdale in this area.
25.9	.3	Outcrop on both sides of railroad.

STOP 6. (Hampton Quad.) TYPICAL OAKDALE IN FOOTWALL OF NIGHTINGALE BROOK FAULT. This outcrop has all the sedimentary features of the Oakdale seen in Stops 2, 3 and 4. It is a greenish medium-gray metasiltstone, commonly laminated in beds 1 to 20 cm thick interbedded with rusty weathering muscovitic schist intervals 20 cm to perhaps as much as 1 m thick. The rock is deceptively massive looking on some joint surfaces but the weathered outcrop brings out the fine sedimentary layering.

Cum. In.

The contrast of pelitic and metasiltstone layers brings out an intricate pattern of chevron folds, with gently dipping axial planes, that climb nearly vertically across the outcrop. The pelitic beds also appear to be more lightly folded than adjacent metasiltstone intervals. Some slippage has occurred on the metasiltstone-pelitic contacts. The fold axes plunge about 10° to N.25° E., but are variable. The axial planes range from N.70W. to as much as N.40E. and dip 10-20° to the N. Note that the folds are bedding plane folds and there is an absence of axial plane cleavage or any evidence of transposition of bedding. The folding is related to movements in the adjacent Nightingale Brook fault and does not represent a regional fold set.

Return to cars and continue NE on railroad grade.

26.1 .2 Turn right off railroad grade on small woods rd., drive 70 m, turn sharply left on paved rd. and drive N over bridge crossing railroad grade.

26.7 .6 Overgrown rd. on left leads to difficult to find outcrop on S side of topographic knob, about 130 m to the N, that is right on the Eastford town line. This outcrop is very similar to Stop 6, including climbing chevron fold contacts of schists and metasiltstone. This too lies adjacent to the Nightingale Brook fault.

27.1 .4 Small overgrown drive, immediately before stream crossing, leads to deserted house, outcrop of Oakdale at stream behind house. Outcrop is well laminated differentially etched metasiltstone with traces of muscovite.

27.3 .2 T. in rd. turn right, S, on Stetson (Lewis) Rd.

27.5 .2 Lewis Rd., turn right, S, on Rt. 97.

27.7 .2 Bear left at bend in Rt. 97 onto Bigelow Rd.

28.2 .5 Rd. enters on left, continue straight.

28.4 .2 Outcrop on left of the northern end of the Scotland member of the Oakdale is beginning of numerous exposures over the next 800 m.

28.5 .1 Continue to north end of wooden fenced paddock on right, park, cross street and climb 40 m uphill to east to large outcrop.

STOP 7. (Hampton Quad.) SCOTLAND MEMBER. Gently dipping unevenly bedded light-to medium-gray, with silvery sheen, crinkled muscovite schist, fine garnet and staurolite ubiquitous, contains interlayers and crinkled lamellae of metasiltstone. This northern part of the Scotland Member is thinner and generally

Cum.	In.	
		contains more siltstone layers than farther south. Pegmatite pods and stringers present.
		Proceed S scross small fault controlled gully at altitude of top of outcrop to next outcrop. Fault has brought up the underlying Oakdale metasiltstone so that the top of the outcrop is about at the contact with the basal Scotland. The contact appears to be conformable and gradational with interlayering of the two rock types. Proceed across power line right of way along the top of outcrop and drop down face of outcrop just S of power line.
		The Oakdale here has calc-silicate-bearing layers rhythmically interbedded with metasiltstone beds.
		Continue downhill past power station to rd. and return to cars.
		Continue S along N. Bigelow Rd.
29.7	1.4	Cross old Rt. 6.
30.7	.8	Intersection Rt. 6, turn right, W.
30.8	.1	Outcrop on right, Oakdale metasiltstone with calc-silicate-bearing beds. Tightly oppressed, nearly flat lying folds are prominant in this outcrop. Scotland member is exposed in woods above. The character of the folding suggests the contact may be tectonic here.
31.1	.3	Turn left, S, on Rt. 97. Cross bridge right after turn. Oakdale metasiltstone exposed in stream below.
34.6	3.5	Cross Brooklyn Turnpike.
37.0	2.4	Intersection Rt. 97 and 14. Turn right, W.
37.6	.6	Scotland, CT, turn left, S, on Rt. 97.
38.6	1.0	Bear left at cemetery on Rt. 97.
39.0	.4	Good outcrop of Scotland just back of rd. intersection on left.
39.7	.7	Crossing Waldo Brook, outcrop of Oakdale metasiltstone in stream bed to right.
41.2	1.5	Turn right, W, at sign to Brookside greenhouse (Jerusalem Rd.).
41.3	.1	Hills in foreground underlain by Scotland.
41.6	.3	Crossing bridge at base of Scotland, numerous outcrops of

Cum.	In.	
		Scotland along right, N, side of rd. next half mile.
42.2	.6	Small turnout on right side, park and walk through gate down to power house on river. Outcrops along railroad track on both sides power house (if cannot get into power station, visit outcrop uphill from turnout).
		STOP 8. (Scotland Quad.) SCOTLAND MEMBER. Massive contorted schist, bedding difficult to see, except where metasiltstone interlayered with schist. Reddish-brown-weathering muscovite schist with garnet and staurolite. Note quartzite bed about 20 cm thick in schist SE of power house. Some pulled apart beds of calc-silicate-bearing metasiltstone are present. Crinkled surfaces form very irregular lineations 0-20° S.30W. These represent the general plunge of axes of oppressed folds. Pods of pegmatite and vein quartz are present.
		Return to cars and continue NW along Jerusalem Rd.
43.0	.8	Pass Myers Rd. on right.
43.6	.6	Pass Weldon Drive. Outcrop of Oakdale stratigraphically above Scotland on railroad cut directly S below end of Weldon Drive, about 500 m from Jerusalem Rd.
45.6	2.0	End of Jerusalem Rd. at Rt. 203 turn left, S.
46.3	.7	Crossing Shetucket River after railroad.
46.5	.2	Intersection Rt. 32, continue straight, S, on Main St. through S. Windham, CT, and up hill.
46.8	.3	Continue straight passing Sanitorium Rd., fault showing granulated Lebanon Gabbro is exposed about 100 m to right on road.
46.9	.1	Bear right at fork in rd.
48.9	2.0	Intersection Kick Hill Rd. and Chappel Rd. near crest of Kick Hill. Scattered outcrops of mostly schist and metasiltstone occur in this vicinity. These are assigned to the Oakdale rather than Brimfield and Hebron as previously mapped by Snyder.
49.9	1.0	Intersection Kick Hill Rd. and Rt. 207, turn left, NE.
50.1	.2	Entrance to field on right just before stream crossing, park. Scattered low outcrops on brow of hill to S, crossed by power lines.
		STOP 9. (Willimantic Quad.) UPPER PART OF OAKDALE FM. Thin, slightly irregularly-bedded, medium-greenish-gray thin-bedded

Cum. In.

metasiltstone, dipping gently northwest. Muscovite lamellae and beds as much as several cm thick form less than 10 percent of rock. These commonly impart a silvery sheen to bedding surfaces. These exposures are quite unlike the Scotland at the type locality with which they were originally correlated.

Return to cars. End of guided trip. Two additional stops are described below for those with time. The first is along the quickest route to Kingston, R.I.

Turn around, proceed S on Rt. 203.

50.3 .2 Passing Kick Hill Rd.

51.3 1.0 Lebanon, CT, turn left, E, on Rt. 87.

56.3 5.0 Exposures on both sides of rd.

STOP 10. (Fitchville Quad.) LOWER OAKDALE - SCOTLAND MEMBER CONTACT. This stop shows features almost identical to those at Stop 7 (Hampton Quad.). Well bedded and thinly layered Oakdale metasiltstone with prominant calc-silicate-bearing layers underlies rusty weathering muscovite schist. The contact is conformable and gradational. The rusty weathering schist at east edge of outcrop, however, is probably a repetition due to faulting.

57.9 1.6 Intersection Rt.32, turn right, S, exposures of Canterbury Gneiss.

58.5 .6 Intersection Rt. 32 and Rt. 2.

To see exposures of the Hebron Formation unlike the Oakdale Fm. and more similar to the Southbridge, take Rt. 2 west to exposures along highway about 1 mile beyond Gilman, CT, (Exit 22). To go directly to Kingston, R.I. take Rt. 2 east and follow instructions below Stop 11.

STOP 11. (Fitchville Quad.) HEBRON. These roadcuts consist of gray to greenish-gray medium-grained calc-silicate-bearing biotite schistose granulite in thin to medium slightly uneven beds. The bedding is nearly horizontal with numerous low angle recumbent folds showing NW over SE sense of transport. Very strong penetration axial plane lineation trends approximately 10^{o} N.15W. The numerous small low angle thrust faults show the same sense of transport. These outcrops lie in the footwall of a very low angle thrust fault that is eroded here, but exposed to the W where Bigelow Brook Fm is in the upper plate, that forms the Colchester nappe.

To proceed to the Univ. of R.I., Kingston, R.I., take Rt. 2 east to Rt. 52, north on Rt. 52 to Rt. 138 exit (exit to Pachaug, alternate route to R.I. beaches) and east on Rt. 138 to Kingston.